Title: Surface Generation by Range Data Fusion using Hybrid Structured Light Systems

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Next-Best-View, Kinect
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Abstract: In the last twenty years, many coherent and non-contact range acquisition techniques for contact-free measurement of object surfaces based on optical sources have been presented; but often they still require complex and expensive devices. Therefore, the first aim of this research is to the development of an inexpensive range sensor using commercially available an electro-mechanical devices. Next, a new calibration methodology of a range sensor is presented using the encoded pattern for acquisition of range information. Often, with one acquisition, it is not possible to fully digitize the whole geometry of the scene. In the latter section, a new technique of next-best-view (NBV) is presented to determine from which directions to scan a scene so that a complete description of its surface can be acquired. Since, each range sensors have its limitations, e.g. in terms of field of view, accuracy, resolution and noise, etc. Therefore, in the last section, the following range data fusion approaches have been presented using heterogeneous range sensors, i.e., Kinect system and Laser range sensor: (1) A new unsupervised 3D fusion method based on Haar wavelet analysis of depth image obtained from Kinect is presented. The Haar wavelet transform of the depth image determines the scene characteristic, i.e. finer and coarser regions. Based on segmentation criterion, the fusion of range data is performed by integration of finer region's range data acquired from a Laser range sensor with the coarser regions of the Kinect dataset. (2) Next, a new supervised range data fusion method is proposed by fitting the Gaussian Mixture Model (GMM) using a convex relaxation approach on a labelled training dataset. Based on the surface complexity, the fused surface model is generated which represent more descriptive contents of the scene.

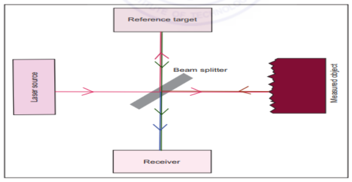


Figure 1.2: Michelson interferometer

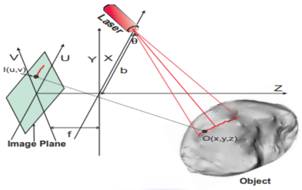


Figure 1.3: Principles of laser triangulation

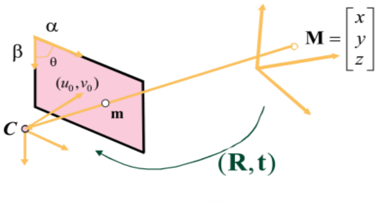


Figure 2.1: Pinhole camera model.

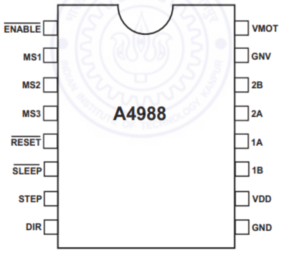


Figure 3.4: Micro-stepping motor driver A4988.

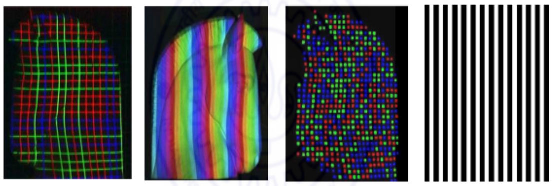
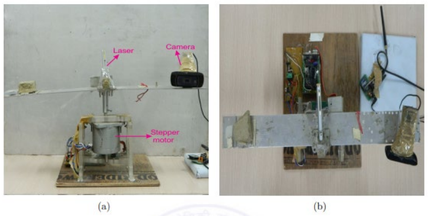


Figure 1.4: Coded structured light patterns



(a) (b)

Figure 3.1: Hardware setup of Laser range sensor: (a) front view and (b) top view.

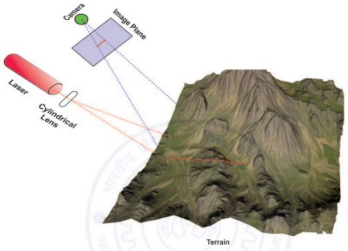


Figure 3.7: Optical triangulation.